United States Department of Agriculture
Bureau of Entomology and Plant Quarantine

SUPPLEMENTARY CONTROL MEASURES FOR REDUCING INSECT INFESTATION IN THE FLOUR MILL

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The elimination of insect troubles in a flour mill by means of a general fumigation performed once a year would be an almost ideal arrangement. Unfortunately such a program of insect control is not entirely adequate because insects are constantly being introduced into the mill on or in infested grain and flour used for blending purposes, so that in some cases a mill that may have been entirely freed of live insects by a good general fumigation becomes heavily reinfested within a few weeks.

The general fumigation is an essential part of the insect-control program of every modern mill; however, there are many supplementary measures the practice of which will aid materially in the production of an insect-free product. It is with these supplementary measures that this paper deals.

Seasonal Variation in Insect Population in Mills

A study of the fluctuating insect population (fig. 1) in flour mills, as revealed by monthly samples taken from the milling streams of representative mills, shows that in general the insect population is small in winter, rises rapidly in spring, is reduced to a low ebb in July by means of general fumigations, and rises rapidly again until fall, when it begins to decline with the advent of cold weather. The upward trend of the population from December to January shown in the chart is due to an unusually heavy running schedule of some of the mills under observation. In mills that run continuously, 24 hours a day, the temperatures of the milling streams during the winter months are quite high and provide conditions ideal for insect development.

The curves in figure 1 show the variations in the average monthly insect populations of 21 mills, as represented by the insects contained in 8-ounce samples taken from 21 milling streams of each mill during the period of April 1934 to April 1935. The total population represented by these small samples would naturally be very much greater. It can be readily seen that such an insect population would make the production of a clean product exceedingly difficult.

Effect of Certain Supplementary Control Measures on Mill Insects

The effect of certain supplementary control measures on the insect population of flour mills is shown in figures 2, 3, and 4.

In figure 2 a comparison is given of the insect population (in 8-ounce samples) in a mill in September 1932 and in the same month in 1934.

In 1932 this mill received a general fumigation, but no supplementary control measures were practiced, whereas in 1934 no general fumigation was given, but the elevator boots were cleaned out regularly every two weeks and the accumulations from them fumigated before being fed back into the mill.

Although the insect population of this mill was eliminated, in August of 1932, by means of a general fumigation, the September survey showed a considerably higher population than at the same time in 1934 when the practice was followed of cleaning out the elevator boots every two weeks.

It is interesting to note that an examination of the flour redress reels and conveyers in this mill in September 1934 showed a heavy infestation of flour beetles. If local fumigations of the redress reels and flour conveyers had been periodically practiced, in addition to the other measures, the insects would have been very satisfactorily controlled.

In figure 3 is shown the average monthly insect population (in 8-ounce samples), from October 1934 to March 1935, in a mill in which the only method of control practiced was the biweekly cleaning of the elevator boots. Although the insect population of this mill was kept at a relatively low figure, the numbers and location of the insects revealed by the collections indicate the advisability of using some good local fumigant in the purifier and reel conveyers.

In figure 4 a comparison is made of the insect population of 4 mills in which different methods of insect control were practiced.

Mill No. 1 was operated on a 24-hour schedule during the months of December and January, and the high insect population in January was due to the optimum temperatures of the mill streams occasioned by this heavy running schedule. This mill received no treatment whatever for insect control.

Mill No. 2 operated on an 8-hour-day running schedule, hence the lower temperatures of winter exerted their normal effect of reducing insect abundance. This mill received a general fumigation in June, but no other control measures were practiced.

Mill No. 3 received a general fumigation, and in addition the elevator boots were cleaned out periodically and the accumulations fumigated before being fed back into the mill.

Mill No. 4 received the same treatment accorded Mill No. 3, but in addition periodic local fumigation of the purifier and reel conveyers was practiced.

It can be readily seen that in Mills 1 and 2 the intensity of the insect population was near the danger point during the greater part of the year, while in Mills 3 and 4 the population was kept low at all times. This is satisfactory evidence that the practice of cleaning out the elevator boots every two weeks, plus the periodic local fumigation of purifier, reel, and flour conveyers, is vitally important in controlling insect infestation in the mill.

Since insects are continually being introduced into milling machinery by means of infested grain and flour used for blending, and since the eggs and small larvae are not all killed by the rolls, they become established in accumulations of flour products in dead spaces in the machinery, multiply rapidly, and form reservoirs of infestation for the various milling streams.

Supplementary Measures Recommended for the Control of Mill Insects

Observations over a period of years have revealed that many of these reservoirs of infestation can be eliminated by rearranging or remodeling portions of the milling machinery or by slight changes in the flow of the mill. By making such changes many millers have materially reduced infestation in their milling machinery and in their finished flour.

Segregating the grain-cleaning machinery.--Owing to the fact that grain is one of the most important sources of insect infestation in the mill, the grain-cleaning machinery should be segregated from the other portions of the mill, and the conveying of uncleaned grain through the mill or warehouse avoided.

In many mills the grain is conveyed for considerable distances through the mill or warehouse before it reaches the cleaning machinery, thus affording opportunity for insects in the grain to crawl from the conveyers and drop onto the mill machinery or the bags of finished flour. This practice is frequently responsible for the infestation of flour products by such insects as the saw-tooth grain beetle, the grain weevil, and the grain borer, insects that are primarily pests of stored grain.

Grain screenings should be disposed of immediately, by spouting to the screenings grinders, since all active stages of grain weevils will be killed by the grinding process. It should be observed at this time that flour beetles are not classed as grain weevils and that their small larvae cannot be killed by the screenings rolls or hammer mills. If, as in some mills, the screenings are bagged in the cleaning room, the insects in these screenings are able to crawl to the mill streams and the finished flours.

Preventing accumulations of flour products under machinery.--Accumulations of flour products under machinery provide ideal situations for the breeding of insects and constitute a constant source of infestations both of the Mediterranean flour moth and of the flour beetles. These accumulations can be readily prevented by raising conveyers and elevator boots sufficiently high above the floor to allow easy access for the sweeper's broom.

The raising of elevator boots from the floor also eliminates the possibility of insects crawling from one boot to another and facilitates the periodical removal of accumulations from such boots. (Fig. 5.)

Preventing accumulations in the machinery.--Poorly designed conveyers and elevator boots are responsible for the creation of many accumulations of flour products that harbor large populations of flour beetles. Investigations at one flour mill, during the clean-up process before a fumigation, revealed the fact that the flour in the clear flour conveyer contained 4,820 living adults and 3,000 live larvae of the flour beetle, while in the patent flour conveyer the flour contained 1,800 live adult beetles and 2,400 live larvae.

Rectangular conveyers having flat bottoms are responsible for many such accumulations. By substituting a metal bottom, rounded to conform to the size and shape of the worm, or by the insertion in the old conveyer of specially cut lengths of wood that conform to the shape of the worm, the dead space in the conveyers created by the square corners can be eliminated and accumulations prevented. At this point a word should be said regarding the use of drags in conveyers. In the old-type flat-bottom conveyer the drag type of conveyance is more efficient in preventing accumulations of flour; however, owing to structural weaknesses this type of conveyer has been largely replaced by the worm type. Dead space in elevator boots can be eliminated by substituting rounded metal bottoms (fig. 6) for those of the square type. Metal slides for round-bottom boots have been found as satisfactory as the old-style slide.

Elimination of dead spouts and conveyers.--Whenever a change in milling practice necessitates the discontinuance of certain slide spouts or conveyers and there is no prospect of their immediate return to use they should be removed, otherwise accumulations of flour will inevitably occur in them and provide ideal conditions for the breeding of insects.

Conveyers can be entirely eliminated from purifiers by the use of hoppers shaped to fit snugly under the different areas of cloth. This design of machine entirely eliminates the trouble of accumulations so prevalent with conveyers.

Proper location and use of redressing machinery.--For the elimination of insect life in the finished flour it is essential that the right kind of rebolting machinery be used and that it be located properly in the mill. For maximum efficiency and in order to prevent the possibility of reinfestation, the redressing machinery should be placed directly above the packer bins. If it is placed before the chlorine agitators in such a manner that an extensive system of conveyers is required to transport the finished flour to the packer bins, additional opportunity for reinfestation by insects is afforded.

Contrary to the general belief, the chlorine treatment is not effective against insects. The writers have taken all stages of the flour beetles in a living condition from chlorine agitators. In one mill, examined during the clean-up process before a general fumigation, a clear agitator was found to contain 77 adults, 26 larvae, and 5 pupae of the confused flour beetle in a living condition. Similarly a patent agitator was found to contain 48 living adults, 30 larvae, and 5 pupae of the confused flour beetle.

Sifters, instead of reels, should be used for redressing flour, since conveyers in reels (fig. 7) are so arranged that it is a simple matter for insects removed in the redressing process to crawl over into the conveyer handling the finished flour. Sifters (fig. 8) are so constructed that the tail-over and the finished flour are handled by separate slide spouts that have no connection, thus making it impossible for insects to crawl from one stream to the other.

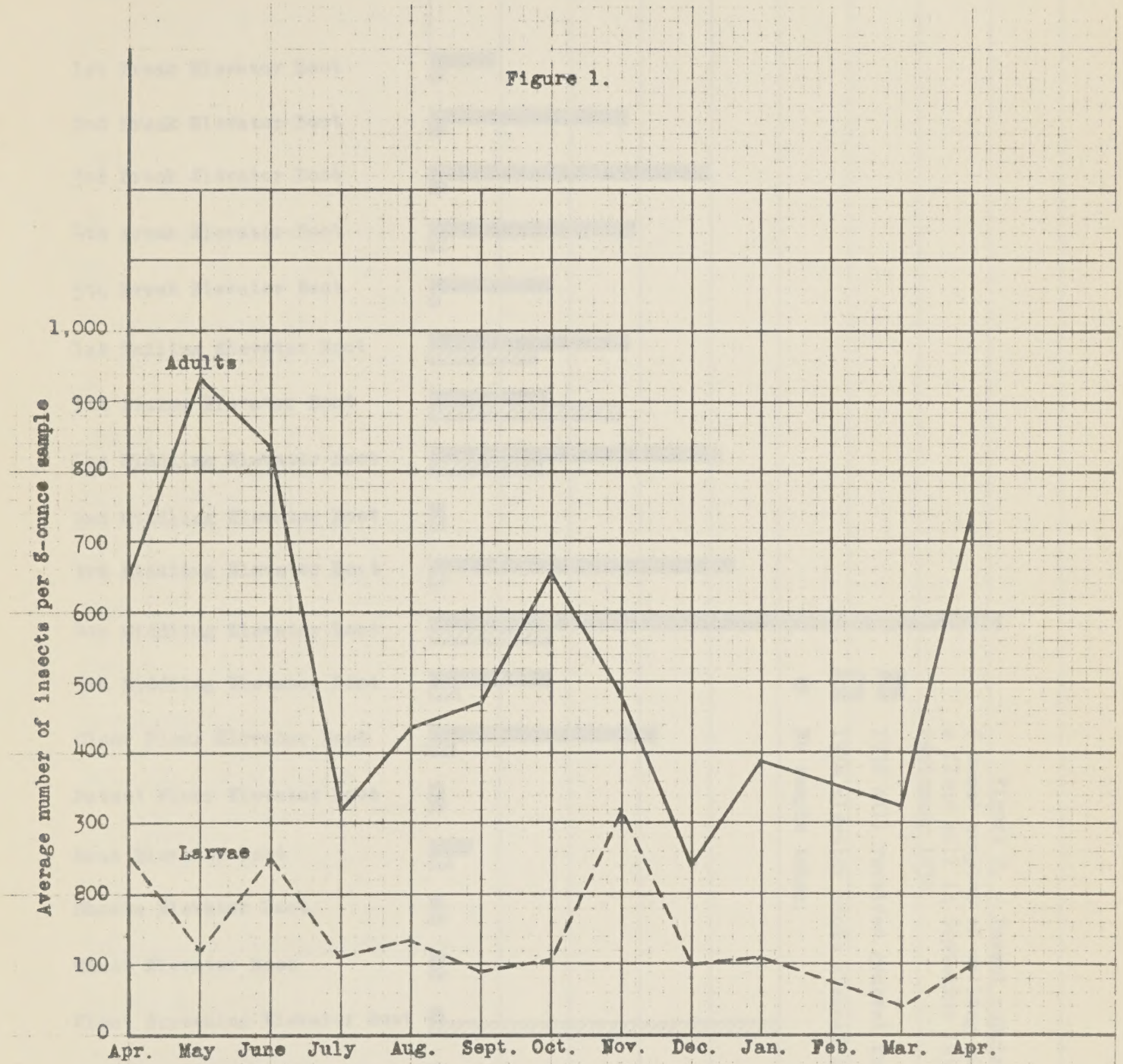
The writers have observed that infestation in the finished flour is closely correlated with the method of handling it during the final operations. Where no effort is made to redress the flour, insect infestation is almost invariably present. Where redress reels are used, infestation of the finished flour is less common, since insects are removed by the reels and reinfestation occurs only when the insect population of the tail-over conveyer reaches a point where crowded conditions induce migration of the insects to the finished-flour conveyer. Mills that use sifters for redressing their flour are seldom troubled with infestations in the finished flour as it comes from the packers. Milling engineers state that, when comparative capacities are considered, the use of sifters for the redress operation is economical both from the standpoint of cost of operation and in space occupied.

Storage of mill products for insect control.--The storage of feeds and flours is a problem in every mill, particularly when clears and low grades are purchased in quantity for blending purposes.

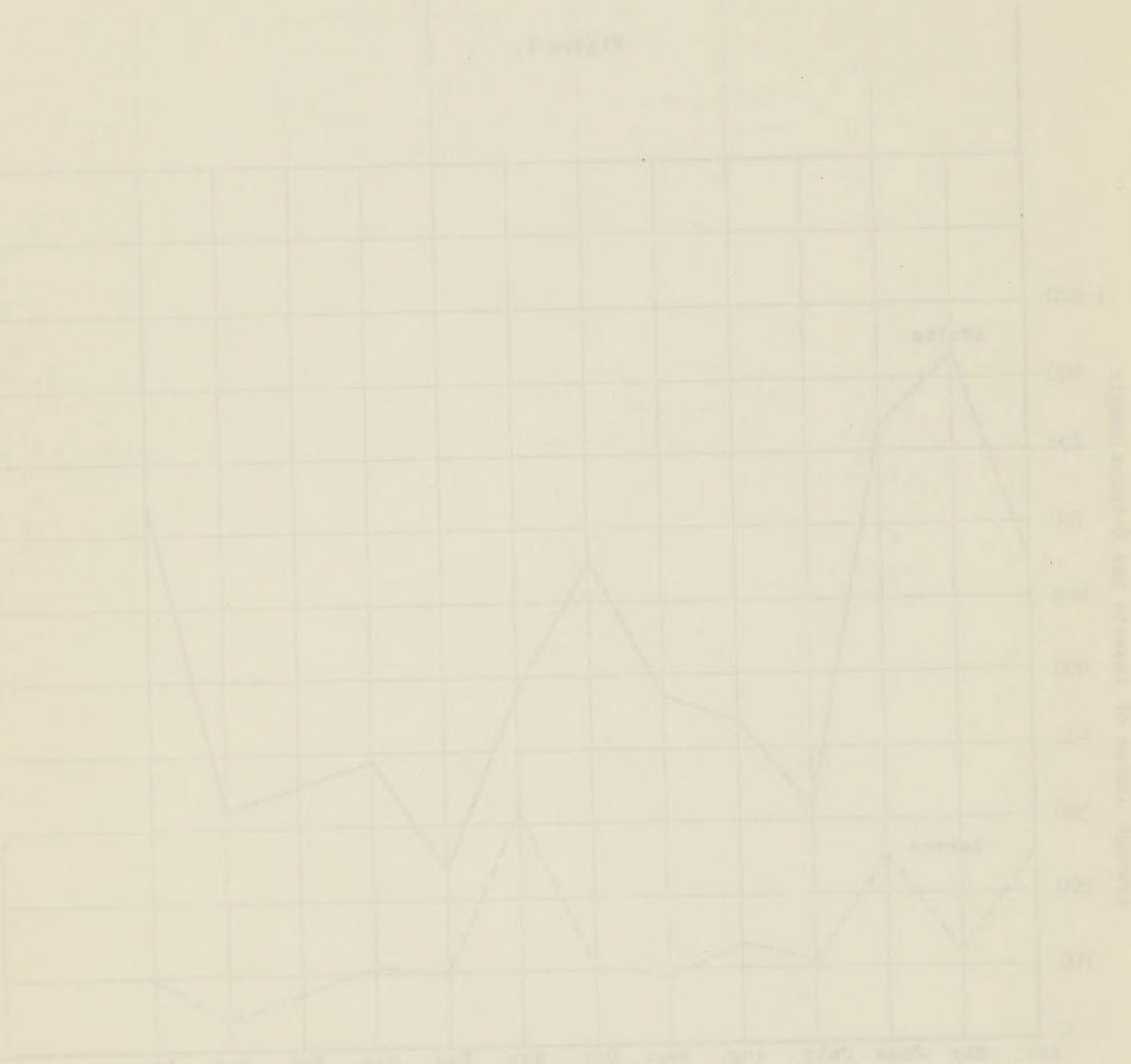
Since shorts usually receive the ground screenings, this feed is almost invariably infested. It should be stored as far away as possible from the mill and finished flour in order to prevent the possibility of insects crawling from the feed to the mill or flour warehouse. Similarly clears and low-grade flours purchased for blending operations should be so stored that contamination from this source will be prevented.

The practice of storing flour near elevator boots or milling machinery invariably results in infestation of the flour. Finished flour should, if possible, be stored separately in clean warehouses. If warehouse space does not permit separate storage of finished flour, it should be stored as far distant as possible from feeds and lots of flour known to be infested.

Figure 1.



Average monthly insect populations of 21 flour mills, as indicated by 8-ounce samples taken from each of the milling streams of these mills.



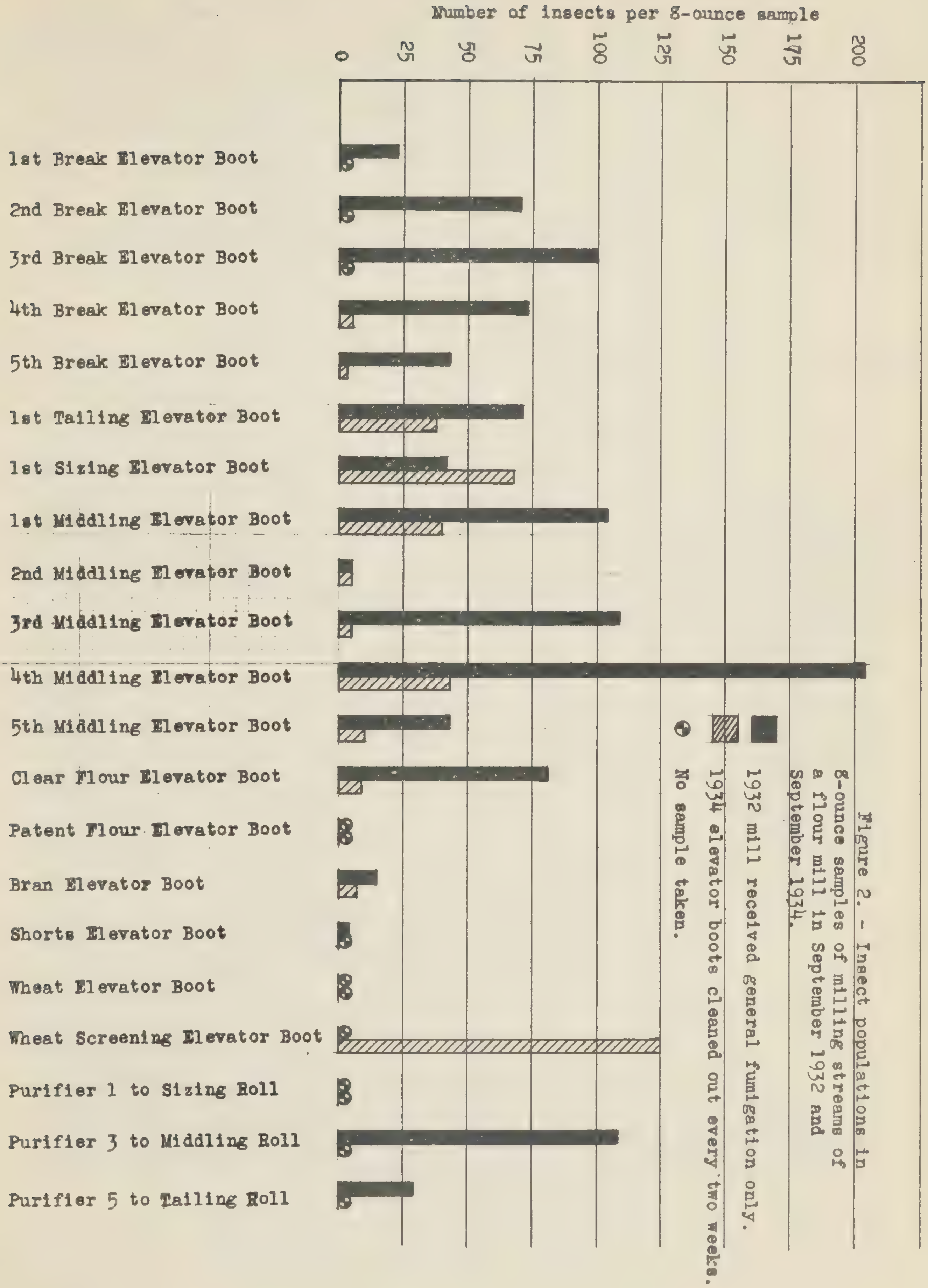


Figure 2. - Insect populations in 8-ounce samples of milling streams of a flour mill in September 1932 and September 1934.

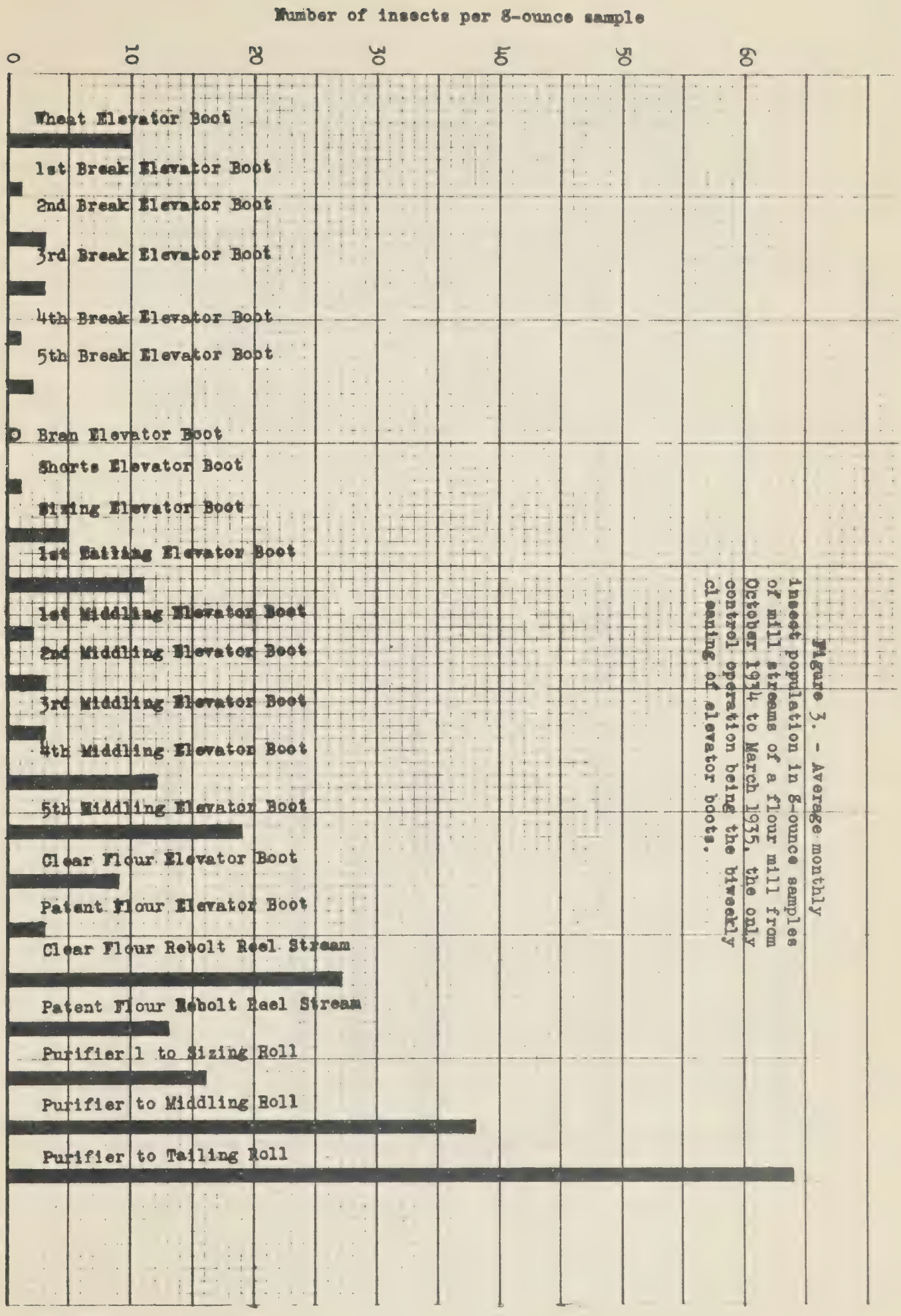
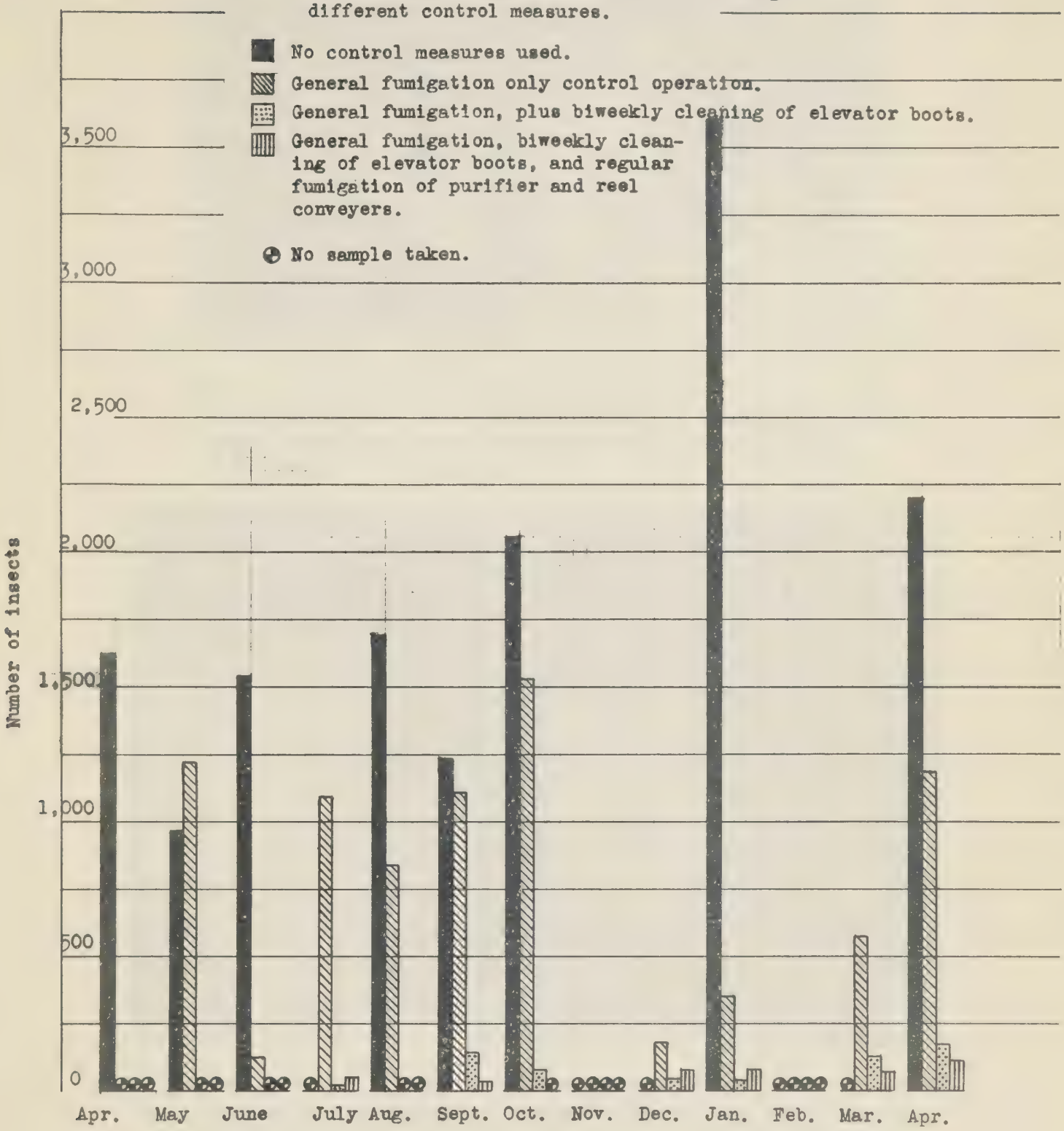


Figure 3. - Average monthly insect population in 8-ounce samples of mill streams of a flour mill from October 1934 to March 1935, the only control operation being the biweekly cleaning of elevator boots.

Figure 4. - Comparison of the insect populations in 10 1/2 pounds of mill products from the milling streams of 4 flour mills using different control measures.



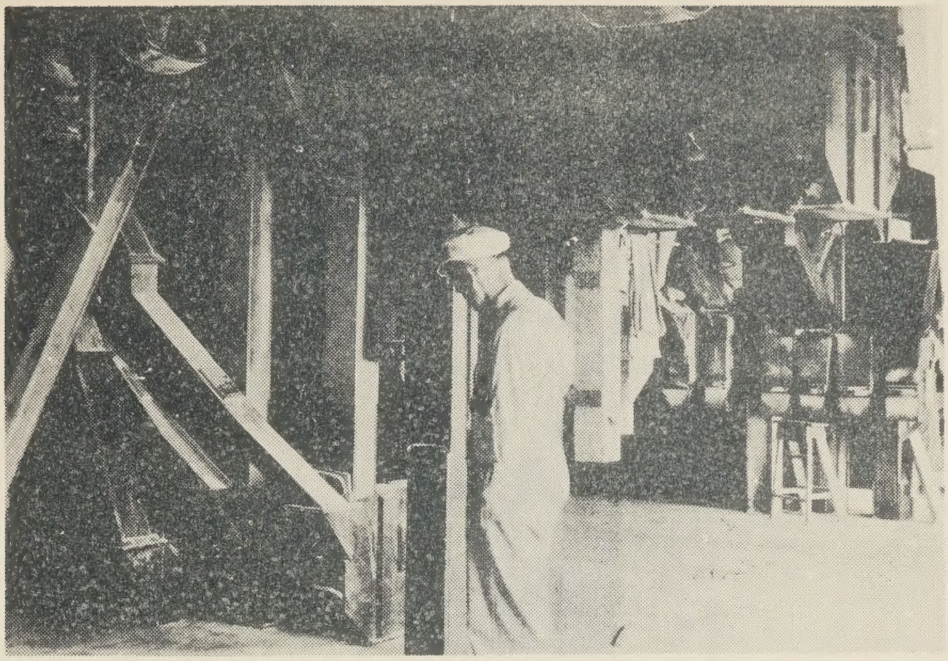


Figure 5.--The raising of elevator boots from the floor facilitates the periodical removal of accumulations, and eliminates the possibility of insects crawling from one boot to another.

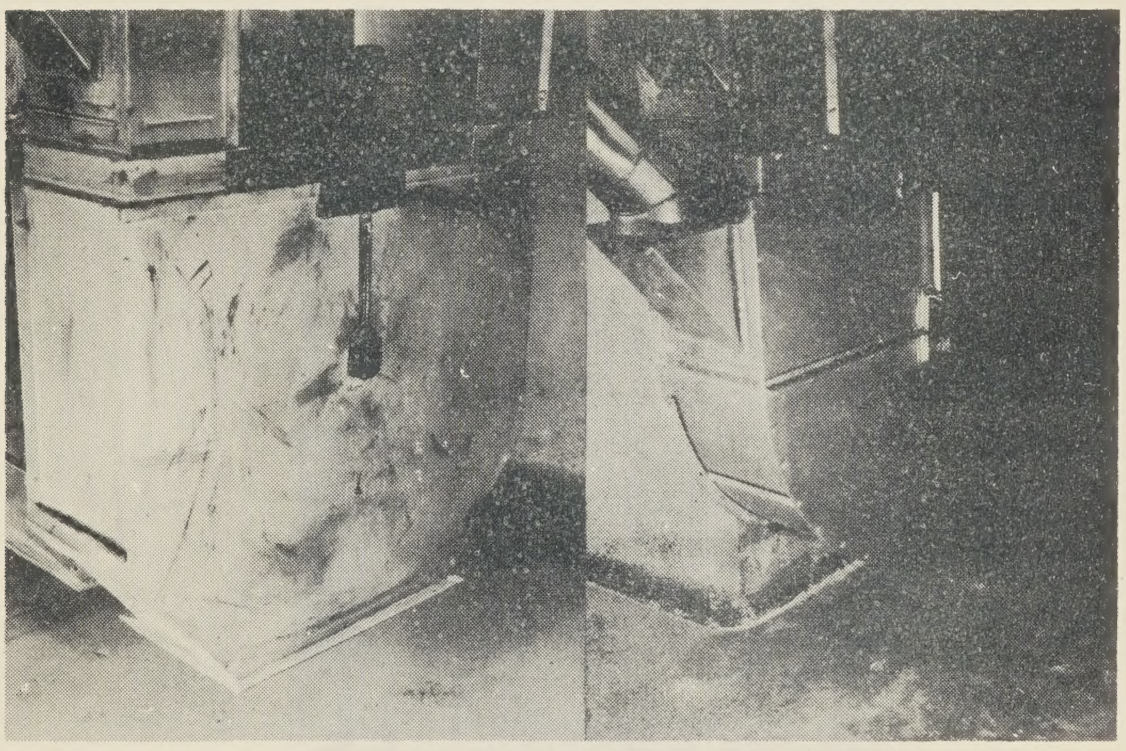
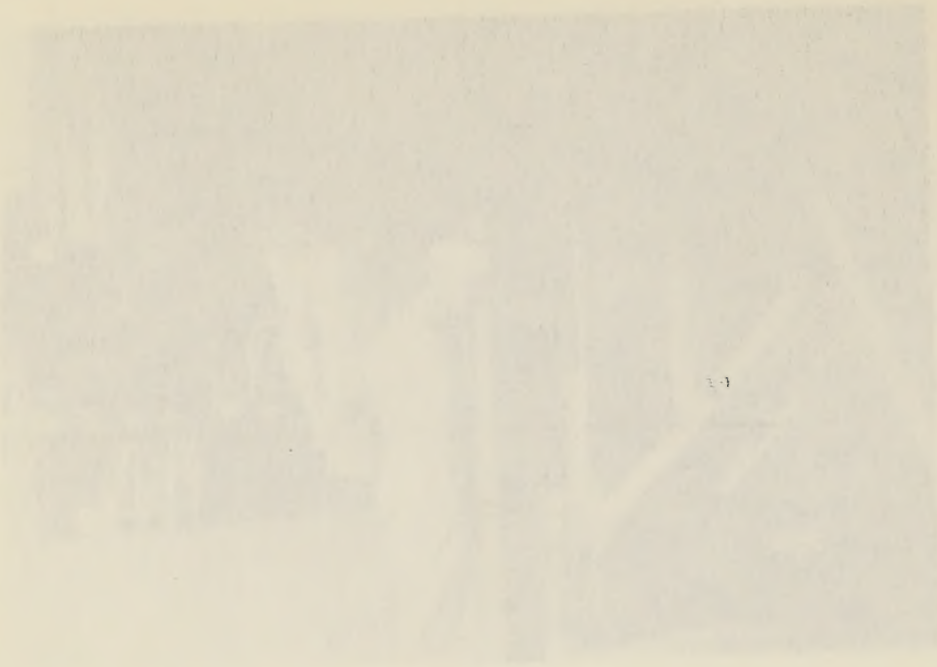


Figure 6.--Two types of metal elevator boots; dead space in elevator boots can be eliminated by the substitution of rounded metal bottoms for those of the square type.



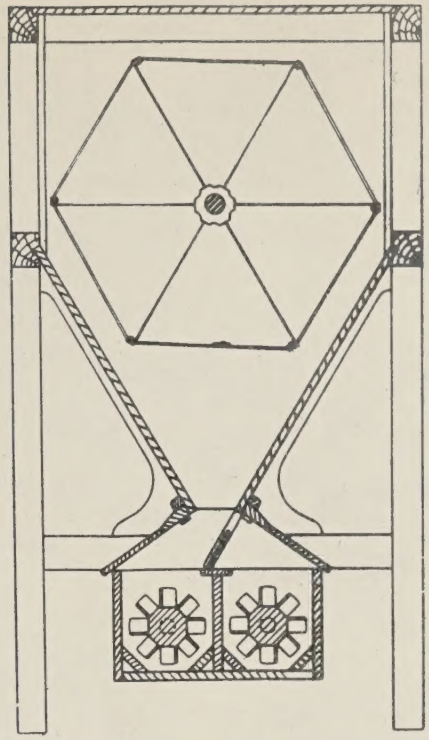


Figure 7.--Cross section of redressing reel, showing close connection between flour and tail-over conveyers. When heavy infestations are allowed to build up in the tail-over conveyer, insects crawl over into the finished-flour conveyer.

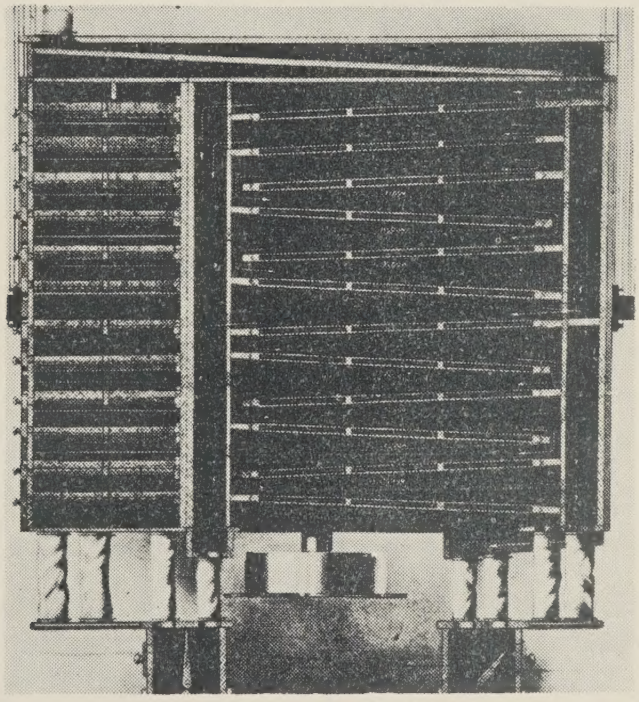


Figure 8.--Cross section of sifter showing complete separation of flour stream from the tail-over stream. There is no possibility of the flour stream becoming infested with insects from the tail over.